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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appl. No. : 10/685,631 Confirmation No. 4989
Appellant : James T. Beals et al.
Filed : October 15, 2003
TC/A.U. : 1725
Examiner : Ing Hour Lin

Docket No. : EH-11057(03-545)
Customer No. : 52237

MS Appeal Breif-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313

APPEAL BRIEF

Sir:

This is an appeal to the Board of Patent Appeals and Interferences from the final rejection of claims 1 - 24, dated January 11, 2005, made by the Primary Examiner in Group Tech Center 1725.

REAL PARTY IN INTEREST

The real party in interest is United Technologies Corporation of Hartford, Connecticut.

RELATED APPEALS AND INTERFERENCES

There are no other prior and pending appeals, interferences or judicial proceedings known to Appellants, Appellants' legal representative, or Assignee which may be related to, directly affect, or be directly affected by or have a bearing on the Board's decision in the pending appeal.

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STATUS OF CLAIMS

Claims 1 - 24 are pending in the application and are on appeal. An appendix containing the claims on appeal is attached hereto.

STATUS OF AMENDMENTS

No amendment was filed subsequent to the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

The claims on appeal relate to a casting system that includes a refractory metal core. The refractory metal core has a means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting. The oxidation resistance and protection providing means is formed by a coating. See page 2, paragraph 0013.

The refractory metal cores may be formed by metals selected from the group consisting of molybdenum, tantalum, niobium, tungsten, alloys thereof, intermetallic compounds thereof. A preferred material for the refractory metal core is molybdenum and its alloys. See page 4, paragraph 0022.

Depending on the alloy and condition, molten metal may be in contact with the refractory metal core for a significant amount of time or be rapid. The type/properties of coatings may vary for the different conditions. See page 4, paragraph 0023.

The choice of the coating composition to be used is predicated by many factors. For example, while some reaction with the refractory metal may be desired for good adherence, extensive reaction may embrittle or limit leachability. Also, active alloy additions require a more inert coating. See page 4, paragraph 0024. Another factor is physical property match. For example, a coating which has a coefficient of thermal expansion (CTE) close to that of the refractory metal is desirable to reduce mismatch cracking during processing. Strain compliance or porosity of the coating is another physical property which may be considered. See page 4, paragraph 0025.

In a first embodiment, the coating broadly comprises at least one oxide and/or silicon containing material. See page 2, paragraph 0013. The coating may comprise alumina silicate because it better matches the CTE of refractory metals, a layer formed from silicide, zirconium silicate because it has a compatible CTE, and/or alumina for better compatibility with active alloy additions. See paragraph 0027 on pages 4 and 5.

In a second embodiment, the coating comprises an oxide selected from the group consisting of calcia, magnesia, alumina, zirconia, chromia, yttria, silica, hafnia, and mixtures thereof. See page 3, paragraph 0014; see page 5, paragraph 0028. The coating may contain chromia and further comprise a chromium coating applied to form the chromia. See page 5, paragraph 0033. Alternatively, the coating may contain silica and comprise a silicide coating applied to form the silica. See page 5, paragraph 0033.

In a third embodiment, the coating comprises a nitride selected from the group consisting of silicon nitride, sialon, titanium nitride, and mixtures thereof. See page 3, paragraph 0015; see page 5, paragraph 0028.

In a fourth embodiment, the coating comprises a carbide selected from the group consisting of silicon carbide, titanium carbide, tantalum carbide, and mixtures thereof. See page 3, paragraph 0016; see page 5, paragraph 0028.

In a fifth embodiment, the coating comprises a ceramic coating and at least one layer between the refractory metal forming the refractory metal core and the ceramic coating. See page 3, paragraph 0017; see paragraph 0030 on page 5. The at least one layer may be formed from a metal selected from the group consisting of nickel, platinum, chromium, silicon, alloys thereof, and mixtures thereof. See said paragraph 0030. Alternatively, the layer(s) may be formed from intermetallics such as NiAl, MCrAlY, $MoSi_2$. See said paragraph 0030. Still further, the layer(s) may be formed from carbides and nitrides such as TiC, TiN and Si_3N_4. See said paragraph 0030.

In a sixth embodiment, the coating comprises alumina which has been chemically vapor deposited on a molybdenum refractory metal core having an etched surface. See page 3, paragraph 0018; see page 5, paragraph 0029.

In a seventh embodiment, the refractory metal core has a top coat overlaying the oxidation resistance and protection means. See page 3, paragraph 0019; see page 5, paragraph 0031. The top coat may be formed from at least one of a ceramic material, a metallic material, and an intermetallic material. For example, the top coat may be formed from a material selected from the group consisting of alumina, chromia, yttria, and mixtures thereof. Alternatively, the top coat may be formed from a material selected from the group consisting of nickel, chromium, platinum, alloys thereof, and mixtures thereof. Still further, the top coat may be formed from a material selected from the group consisting of an aluminide, a silicide, and mixtures thereof. See paragraph 0031 on page 5.

In an eighth embodiment, the coating comprises alternating layers of alumina and a material selected from the group consisting of TiCN and zirconia deposited on a refractory metal core formed from molybdenum and having an etched surface. See paragraph 0020 on pages 3 and 4; see page 5, paragraph 0032.

The coatings of the present invention are advantageous in that they have a reduced tendency for microcracking. See page 2, paragraph 0010.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to be reviewed on appeal are as follows:

(1) The rejection of claims 1 - 3 and 5 - 8 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 3,011,233 to Kirtchik in view of U.S. Patent No. 6,749,942 to Wittenauer et al.;

(2) The rejection of claims 9 and 10 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of either U.S. Patent No. 4,096,296 to Galmiche et al. or U.S. Patent No. 5,677,060 to Terentieva et al.;

(3) The rejection of claims 4 and 11 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of U.S. Patent No. 5,514,482 to Strangman;

(4) The rejection of claim 12 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of U.S. Patent No. 5,070,591 to Quick et al.;

(5) The rejection of claims 13 - 17 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of U.S. Patent No. 6,299,988 to Wang et al.;

(6) The rejection of claim 18 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of Wittenauer et al. and further in view of U.S. Patent No. 5,270,112 to Lukco et al.;

(7) The rejection of claims 19 - 23 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of U.S. Patent No. 4,404,009 to Bhatti et al.; and

(8) The rejection of claim 24 under 35 U.S.C. 103(a) as being unpatentable over Kirtchik in view of U.S. Patent No. 6,620,525 to Rigney et al.

ARGUMENT

(a) Patentability of Claims 1-3 and 5 - 8

The rejection of claims 1 - 3 and 5 - 8 over Kirtchik in view of Wittenauer et al. fails because there is nothing in Wittenauer et al. which would lead one to apply either a silicon containing coating and/or an oxide coating to a refractory metal core which is used in a casting system. The Wittenauer et al. patent is directed to a thermal protection system for use on a spacecraft such as the space shuttle. The protective tiles to be adhered to the vehicle includes a base structure made of a ceramic oxide material and a silicide coating. The protective tiles have absolutely nothing to do with a casting system and how to provide a means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting. In fact, they serve no useful purpose in a casting system. In a typical casting system, the refractory core, including any coating is chemically removed from the final product. The thermal protection tiles of Wittenauer et al. are not intended to be removed in such a manner.

At best, the Examiner through the citation of Wittenauer et al. has merely shown ceramic oxide materials and silicide coatings to be known in the art. However, this is insufficient to form a proper obviousness rejection. Most if not all inventions arise from a combination of old elements. See *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457 (Fed. Cir. 1998). Thus, every element of a claimed invention may often be found in the prior art. See *Id*. However, identification in the prior art of each individual part claimed is insufficient to defeat patentability of the whole claimed invention. See *Id*. Rather, to establish obviousness based on a combination of elements disclosed in the prior art, there must be some motivation, suggestion or teaching of the desirability of making the specific combination that was made by Appellants. See *In re Dance*, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998). Clearly, the Wittenauer et al. patent is not directed to solving the problem which Appellants' invention solves. It is directed to solving a very different problem having to do with the re-entry of spacecraft into the Earth's atmosphere. Given this, one of ordinary skill in the art would not be motivated to provide either an oxide coating or a silicide coating as a result of Wittenauer et al. Further, the Examiner has not pointed to any statement in either patent which would motivate one of ordinary skill in the art to arrive at the claimed invention. For these reasons, claims 1 and 8 are clearly allowable.

Claims 2, 3, and 5 - 7 are allowable for the same reasons as claim 1.

Claim 2 is further allowable because Wittenauer et al. does not teach forming a coating comprising alumina silicate. Wittenauer et al. merely teaches using alumina/silica blends for the substrate, not the coating. Again, there is nothing which would motivate one of ordinary skill in the art to arrive at the claimed invention.

Claim 5 is allowable because Wittenauer et al. does not teach using alumina as a coating.

Claim 8 is further allowable because neither Kirtchik nor Wittenauer et al. teaches a coating comprising an oxide selected from the group consisting of calcia, magnesia, alumina, zirconia, chromia, yttria, silica, hafnia, and mixtures thereof.

(b) Patentability of Claims 9 and 10

With regard to the rejection of claims 9 and 10 over Kirtchik in view of either Galmiche et al. or Terentieva et al., it should be noted that both of these claims depend from claim 8. The rejection is defective on its face because there is no mention of the Wittenauer et al. reference which was used to reject claim 8. Further, the rejection is defective because nowhere has the Examiner addressed why one of ordinary skill in the art would be motivated to use the subject matter of either Galmiche et al. or Terentieva et al. given the fact that Wittenauer et al. teaches silicide coatings. Is the Examiner replacing the silicide coatings of Wittenauer et al.? If the coating is being replaced, what would motivate one of ordinary skill in the art to do that given the fact that Wittenauer's coating is used as part of a thermal protection system for a spacecraft? None of this addressed by the Examiner in the rejection and thus, the rejection is defective and should be withdrawn. For these reasons, claims 9 and 10 are allowable.

Once again, at best, the Examiner has merely found certain claimed materials to be known in the art; however, this is insufficient to establish a *prima facie* case of obviousness. See *In re Rouffet*, 149 F.3d at 1357. Galmiche et al. is directed to forming a surface diffusion alloy layer on a refractory metal article such as a turbine engine blade or vane. It has nothing to do with a casting system and/or the problems solved by Appellants' invention. The same is true for Terentieva et al. which is directed to a coating having a healing layer for stopping, filling, or sealing the cracks. Claim 9 is further allowable because Galmiche et al. does not teach a coating containing chromia and a chromium coating applied to form the chromia. Claim 10 is further allowable because Terentieva et al.

does not teach a coating containing silica and a silicide coating applied to form the silica. Terentieva et al. does not form a silicide coating which forms silica.

(c) Patentability of Claims 4 and 11

Claim 4 depends from claim 1. Thus, the rejection of claim 4 is defective because there again is no mention of the Wittenauer et al. reference in the rejection of this claim. The rejection is further defective in that there is no discussion of why one would be motivated to use zirconium silicate having modified Kirtchik in view of the alleged teachings of Wittenauer et al. See *In re Dance*, 160 F.3d at 1343. Claim 4 is also allowable because Strangman lists zirconium silicate in a laundry list of materials that may be useful as columnar type coating materials. The Examiner has not explained why one of ordinary skill in the art would be motivated to select zirconium silicate from this laundry list to use in refractory metal cores in a casting system given the fact that Strangman has no relationship to a casting system. To establish a *prima facie* case of obviousness, the Examiner must show some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. See *In re Fine*, 837 F.2d 1071, 1074 ,5 USPQ2d 1596, 1598 (Fed. Cir. 1988). Again, all the Examiner has found is that zirconium silicate is a known material. This is insufficient to establish a *prima facie* case of obviousness. See *In re Rouffet*, 149 F.3d at 1357.

Claim 11 is allowable for the same reasons as claim 4 as well as the following reason. There is nothing in Strangman which would guide one of ordinary skill in the art to select silicon nitride from the laundry list of materials which may be useful as columnar type coating materials and use the silicon nitride as a coating for a refractory metal core in a casting system. The Examiner has failed to set forth any motivational reason why one of ordinary skill in the art having Strangman before him would select the claimed material and understand how it solves the problems encountered by a refractory metal core in a casting system.

(d) Patentability of Claim 12

Claim 12 is directed to a casting system which includes a refractory metal core and an oxidation resistance and protection casting comprising a carbide selected from the group consisting of silicon carbide, titanium carbide, tantalum carbide, and mixtures thereof.

As noted by the Examiner in the rejection the Kirtchik et al. patent does not teach or suggest the claimed coating. The Quick et al. patent being used by the Examiner to cure the deficiencies of Kirtchik is directed to a method for clad coating refractory metal particles. The particles have a size on the order of 10 microns or less. See Quick et al., column 2, lines 64 - 68. Particles of this size have no use as a refractory metal core. It is clear that Quick et al. is not directed to providing a refractory metal core used in a casting system with a particular type of coating and/or the problems solved by Appellants. The materials in Quick et al. are intended for use on microelectronic ceramic substrates and for metal matrix compositions. There is nothing in Quick et al. that would motivate one of ordinary skill in the art combine the references in the manner suggested by the Examiner. For this reason, claim 12 is allowable.

(e) Patentability of Claims 13 - 17

Claim 13 is directed to a casting system having a refractory metal core with a coating comprising a ceramic coating and at least one layer between the refractory metal forming the core and the ceramic coating.

Kirtchik does not teach or suggest the ceramic coating with the intermediate layer. The Wang et al. patent is intended by the Examiner to be a teaching of the missing subject matter in Kirtchik. However, the Wang et al. patent does not provide the necessary teaching in Appellants' opinion.

Wang et al. relates to the formation of an article having a silicon containing substrate and an external environmental/thermal barrier coating. As stated in the Wang et al. Abstract, the coating is permeable to diffusion of an environmental oxidant and the substrate is oxidizable by reaction with the oxidant to form at least one gaseous product. In a casting system, one would never use a coating that would allow the creation of a gaseous product because the gaseous product would create voids and other defects in the article being cast. Claim 13 clearly calls for the core to have means for providing oxidation resistance during shell fire. The coating in Wang et al. would not provide any oxidation resistance. In fact, it is intended to do just the opposite and promote oxidation. Thus, one would not be motivated to use the coating of Wang et al. In fact, Wang et al. teaches away from the claimed invention. Thus, there is no suggestion to combine. See *In re Fine,* 837 F.2d at 1075, 5 USPQ2d at 1598. For these reasons, claim 13 is clearly allowable.

Claims 14 - 17 are allowable for the same reasons as claim 13 as well as on their own accord. Neither Kirtchik et al. nor

Wang et al. teach or suggest a refractory metal core having a ceramic coating and an intermediate layer in which the layer is formed from: a metal selected from the group consisting of nickel, platinum, chromium, silicon, alloys thereof, and mixtures thereof (claim 14); an intermetallic selected from the group consisting of NiAl, MCrAlY, $MoSi_2$, and mixtures thereof (claim 15); or a material selected from the group consisting of TiC, TiN, Si_3N_4, and mixtures thereof (claim 16).

Claim 17 is allowable because neither of the cited and applied references teaches the claimed combination of elements including the ceramic coating being an oxide material.

(f) Patentability of Claim 18

Claim 18 has been rejected over Kirtchik in view of Wittenauer et al. and Lukco et al. The combination of Kirtchik and Wittenauer et al. fails for the reasons set forth in connection with the rejection of claim 1, which reasons are incorporated herein. The Lukco et al. patent does not cure the deficiencies of Kirtchik and Wittenauer et al.

The Lukco et al. reference relates to a hybrid reinforcement material comprising a refractory metal core having a first coating comprising $Al_xO_yN_z$ and a second SiC coating. The purpose of the Al-O-N material layer is to inhibit the diffusion of Si and C into the refractory core metal material. The hybrid reinforcement may be fabricated into various shapes or may be woven or otherwise structured prior to combine with a matrix material. As pointed out in column 4, line 35 et seq., the hybrid reinforcement material of Lukco et al. is disposed into the matrix materials. Lukco et al. is not directed to a casting system and/or to solving the problems solved by Appellants.

Claim 18 is allowable because the references when considered individually or collectively fail to teach or suggest the claimed oxidation resistance and protection providing means comprising an alumina coating which has been chemically vapor deposited.

The rejection of claim 18 is further defective because the Examiner has not indicated why one would be motivated to use the coating technique of Lukco et al. given the nature of Wittenauer's protective tile system. Is the Examiner removing the protective tile system of Wittenauer? Is that why a thermal barrier coating is needed? The rejection offers no insight into the Examiner's position on this point.

(g) Patentability of Claims 19 - 23

Claim 19 stand rejected over Kirtchik in view of Bhatti et al. The Kirtchik et al. patent relied upon by the Examiner fails to teach the use of a top coating. The Bhatti et al. patent is intended to cure this defect in Kirtchik; however, fails in this task.

The Bhatti et al. reference is directed to a feeder for supplying molten streams of glass to be attenuated into fibers and has absolutely nothing to do with a casting system. The feeder comprises a refractory metal core, an oxygen impervious, precious metal sheath, and an intermediate diffusion barrier layer bonded together by hot isostatic pressing to form a unitary laminate having inserts having orifices extending therethrough to establish streams of molten material for attenuation into filaments. There is absolutely nothing in Bhatti et al. which suggests or teaches how to provide means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting. All the Examiner has done is find a reference that has certain materials set forth in claims 19 - 23. This is insufficient to suggest that such materials could, or should, be used in a casting system. It is submitted that the rejection is nothing more than a hindsight rejection.

Even if Bhatti et al. teaches the application of a top coating, the top coating does not overlay an oxidation resistance and protection means. This is not discussed at all in the rejection and thus, the rejection is fatally defective. It is also the reason why claim 19 is allowable over the proposed combination of references.

Claims 20 - 23 are allowable for the same reasons as claim 19 as well as on their own accord.

Claim 20 is allowable because none of the references teach or suggest the claimed combination of elements with the top coat being formed from at least one of a ceramic material, a metallic material, and an intermetallic material.

Claim 21 is allowable because none of the references teach or suggest the claimed combination of elements with the top coat being formed from a material selected from the group consisting of alumina, chromia, yttria, and mixtures thereof.

Claim 22 is allowable because none of the references teach or suggest the claimed combination of elements with the top coat being formed from a material selected from the group consisting of nickel, chromium, platinum, alloys thereof, and mixtures thereof.

Claim 23 is allowable because none of the references teach or suggest the claimed combination of elements with the top coat being formed from a material selected from the group consisting of an aluminide, a silicide, and mixtures thereof.

(h) Patentability of Claim 24

Claim 24 relates to a casting system having a refractor metal core having oxidation resistance and protection providing means which comprise a coating having alternating layers of alumina and a material selected from the group consisting of TiCN and zirconia.

The primary reference to Kirtchik clearly lacks any teaching or suggestion of the claimed coating. The Examiner attempts to use the Rigney patent to cure this deficiency in Kirtchik.

A review of the Rigney patent shows that has nothing at all to do with a casting system and how to protect a refractory metal core. Rigney is directed to putting a multiple layer thermal barrier coating on a turbine blade component which is used in an environment vastly different from a casting system environment. There is absolutely nothing in Rigney which would teach one of ordinary skill in the art to provide any means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting. Thus, there is nothing in the references which would motivate one of ordinary skill in the art to use the thermal barrier coating of Rigney et al. in the casting system of Kirtchik. With regard to the Examiner's statement of motivation, the refractory metal core neither wears or suffers from impacts because the materials with which it works are in the molten state. Thus, the Examiner's statement of motivation is not appropriate and only goes to show the hindsight nature of the rejection.

For these reasons, claim 24 is believed to be allowable.

CONCLUSION

For the foregoing reasons, the Board is hereby requested to reverse the rejections of claims 1 - 24 and remand the application to the Primary Examiner for allowance and issuance.

FEES

The Director is hereby authorized to charge the Appeal Brief fee of $500.00 to Deposit Account No. 21-0279. Should the Director determine that an additional fee is due, he is hereby authorized to charge said fee to said Deposit Account.

Respectfully submitted,

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IN TRIPLICATE

Date: June 13, 2005

I, Nicole Motzer, hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313" on **June 13, 2005**.

Nicole Motzer

APPENDIX

Appl. No. 10/685,631

1. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said oxidation resistance and protection means being a coating comprising at least one oxide and/or a silicon containing material.

2. A casting system in accordance with claim 1, wherein said coating comprises alumina silicate.

3. A casting system in accordance with claim 1, wherein said silicon containing material comprises a layer formed from a silicide.

4. A casting system in accordance with claim 1, wherein said silicon containing material comprises zirconium silicate.

5. A casting system in accordance with claim 1, wherein said oxide comprises alumina.

6. A casting system in accordance with claim 1, wherein said core is formed from a material selected from the group consisting of molybdenum, tantalum, niobium, tungsten, alloys thereof, and intermetallic compounds thereof.

7. A casting system in accordance with claim 1, wherein said core is formed from molybdenum.

8. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said oxidation resistance and protection means being a coating comprising an oxide selected from the group consisting of calcia, magnesia, alumina, zirconia, chromia, yttria, silica, hafnia, and mixtures thereof.

9. A casting system in accordance with claim 8, wherein said coating contains chromia and further comprises a chromium coating applied to form said chromia.

10. A casting system in accordance with claim 8, wherein said coating contains silica and further comprises a silicide coating applied to form said silica.

11. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said oxidation resistance and protection means comprising a coating, said coating comprising a nitride selected from the group consisting of silicon nitride, sialon, titanium nitride, and mixtures thereof.

12. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said oxidation resistance and protection means comprising a coating, said coating comprising a carbide selected from the group consisting of silicon carbide, titanium carbide, tantalum carbide, and mixtures thereof.

13. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said oxidation resistance and protection means comprising a coating, said coating comprising a ceramic coating and at least one layer between the refractory metal forming the refractory metal core and said ceramic coating.

14. A casting system in accordance with claim 13, wherein said at least one layer is formed from a metal selected from the group consisting of nickel, platinum, chromium, silicon, alloys thereof, and mixtures thereof.

15. A casting system in accordance with claim 13, wherein said at least one layer is formed from an intermetallic selected from the group consisting of NiAl, MCrAlY, $MoSi_2$, and mixtures thereof.

16. A casting system in accordance with claim 13, wherein said at least one layer is formed from a material selected from the group consisting of TiC, TiN, Si_3N_4, and mixtures thereof.

17. A casting system in accordance with claim 13, wherein said ceramic coating comprises an oxide material.

18. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said refractory metal core being formed from molybdenum and having an etched surface and

said oxidation resistance and protection providing means comprising a coating, said coating comprising alumina which has been chemically vapor deposited.

19. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, and further having a top coat overlaying the oxidation resistance and protection means.

20. A casting system in accordance with claim 19, wherein said top coat is formed from at least one of a ceramic material, a metallic material, and an intermetallic material.

21. A casting system in accordance with claim 20, wherein said top coat is formed from a material selected from the group consisting of alumina, chromia, yttria, and mixtures thereof.

22. A casting system in accordance with claim 20, wherein said top coat is formed from a material selected from the group consisting of nickel, chromium, platinum, alloys thereof, and mixtures thereof.

23. A casting system in accordance with claim 20, wherein said top coat is formed from a material selected from the group consisting of an aluminide, a silicide, and mixtures thereof.

24. A casting system including a refractory metal core, said refractory metal core having means for providing oxidation resistance during shell fire and protection against reaction/dissolution during casting, said refractory metal core being formed from molybdenum and having an etched surface and

said oxidation resistance and protection providing means comprising a coating, said coating comprising alternating layers of alumina and a material selected from the group consisting of TiCN and zirconia.

CONCLUSION

For the foregoing reasons, the Board is hereby requested to reverse the rejections of claims 1 - 24 and remand the application to the Primary Examiner for allowance and issuance.

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Date: June 13, 2005

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